

**3.1.1 Carbon Dioxide Emissions for U.S. Buildings, by Year (10<sup>6</sup> metric tons of carbon) (1)**

	Buildings				U.S.		Buildings % of Total U.S.	Buildings % of Total Global
	<u>Site</u>	<u>Electricity</u>	<u>Total</u>	<u>Growth Rate</u> <u>2002-Year</u>	<u>Total</u>	<u>Growth Rate</u> <u>2002-Year</u>		
1980	172.0	255.2	427.1	-	1281.7	-	33%	9%
1990	153.6	318.3	471.9	-	1360.5	-	35%	8%
2000	167.9	425.4	593.3	-	1581.5	-	37%	9%
<b>2002</b>	<b>163.9</b> (2)	<b>434.9</b>	(2) <b>598.8</b>	-	<b>1562.5</b>	-	<b>38%</b>	<b>9%</b>
2005	174.0	451.3	625.3	1.5%	1632.5	1.5%	38%	8%
2010	184.4	502.8	687.2	1.7%	1788.8	1.7%	38%	8%
2020	195.5	587.8	783.3	1.5%	2055.2	1.5%	38%	9%
2025	201.0	648.0	849.0	1.5%	2220.6	1.5%	38%	8%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption and exclude energy production activities such as gas flaring, coal mining, and cement production. 2) Emissions differ from EIA, AEO 2004, Jan. 2004, Table A19, p. 158 by less than 1%. U.S. buildings approximately equal the carbon emissions of Japan and France combined.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 1985-1990, Sept. 1993, Appendix B, Tables B1-B5, p. 73-74 for 1980; EIA, Emissions of Greenhouse Gases in the U.S. 2002, Oct. 2003, Tables 6-10, p. 28-30 for 1990 and 2000; EIA, Assumptions to the AEO 2004, Jan. 2004, Table 2, p.8 for carbon coefficients; EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 for 2002-2025 energy consumption and Table A19, p. 158 for 2002-2025 emissions; EIA, International Energy Outlook 2004, April 2004, Table A9, p. 172 for 1990-2025 global emissions; and ORNL, Global CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1995, Jan. 1998 for 1980 global emissions.

**3.1.2 2002 Buildings Energy End-Use Carbon Dioxide Emissions Splits, by Fuel Type  
(10<sup>6</sup> metric tons of carbon equivalent) (1)**

	Natural	Petroleum					Coal	Electricity (3)	Total	Percent
	Gas	Distil.	Resid.	LPG	Oth(2)	Total				
Space Heating (4)	71.4	18.6	1.7	5.1	1.6	27.1	2.8	35.4	136.6	22.8%
Lighting								109.4	109.4	18.3%
Space Cooling	0.2							73.8	74.0	12.4%
Water Heating	25.0	3.8		0.8		4.7		28.3	58.0	9.7%
Refrigeration (5)								46.2	46.2	7.7%
Electronics (6)								32.0	32.0	5.3%
Cooking	6.8			0.5		0.5		12.9	20.2	3.4%
Ventilation (8)								16.2	16.2	2.7%
Wet Clean (7)	1.0							15.1	16.1	2.7%
Computers								10.4	10.4	1.7%
Other (9)	5.5	0.4		4.1	0.9	5.4		24.9	35.8	6.0%
Adjust to SEDS (10)	9.3	4.4				4.4		30.4	44.1	7.4%
Total	119.1	27.2	1.7	10.6	2.5	42.0	2.8	434.9	598.8	100%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle. Carbon emissions calculated from EIA, Assumptions to the AEO 2004 and differ by as much as 0.1% from EIA, AEO 2004, Table A19. Buildings sector total varies by 0.1% from EIA, AEO 2004. 2) Includes kerosene space (1.6 MMTCE) heating and motor gasoline other uses (0.9 MMTCE). 3) Excludes electric imports by utilities. 4) Includes residential furnace fans (3.9 MMTCE). 5) Includes refrigerators (28.7 MMTCE) and freezers (10.4 MMTCE). 6) Includes color television (6.3 MMTCE) and other office equipment. 7) Includes clothes washers (1.6 MMTCE), natural gas clothes dryers (1.0 MMTCE), electric clothes dryers (12.2 MMTCE), and dishwashers (1.2 MMTCE). Does not include water heating energy. 8) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. 9) Includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills and natural gas outdoor lighting. Includes commercial service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, and manufacturing performed in commercial buildings. 10) Emissions related to a discrepancy between data sources. Energy attributable to the buildings sector, but not directly to specific end-uses.

Source(s): EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136, Table A4, p. 139-140 and Table A5, p. 141-142 for energy consumption, and Table A19, p. 158 for emissions; EIA, National Energy Modeling System for AEO 2004, Jan. 2004; EIA, Assumptions to the AEO 2004, Jan. 2004 p. 9 for emission coefficients; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses; BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2; BTP/Navigant Consulting, U.S. Lighting Market Characterization, Volume I, Sept. 2002, Table 8-2, p.63; OBT/A.D. Little, Energy Savings Potential for Commercial Refrigeration Equipment, June 1996, Figure 1-1, p. 1-1; and EIA, AEO 1999, Dec. 1998, p. 120 for 1996 commercial refrigeration.

**3.1.3 2002 Residential Energy End-Use Carbon Dioxide Emissions Splits, by Fuel Type**  
**(10<sup>6</sup> metric tons of carbon equivalent) (1)**

	Natural	Petroleum				Coal	Electricity (2)	Total	Percent
	Gas	Distil.	LPG	Kerosene	Total				
Space Heating (3)	50.9	15.2	5.1	1.3	21.6	0.3	24.6	97.4	30.1%
Space Cooling	0.0						41.4	41.4	12.8%
Water Heating	16.5	2.4	0.8		3.3		21.1	40.8	12.6%
Lighting							39.5	39.5	12.2%
Refrigeration (4)							28.7	28.7	8.9%
Electronics (5)							16.0	16.0	5.0%
Wet Clean (6)	1.0						15.1	16.1	5.0%
Cooking	3.0		0.5		0.5		11.3	14.8	4.6%
Computers							3.3	3.3	1.0%
Other (7)	1.4	0.0	2.5		2.5		9.2	13.1	4.1%
Adjust to SEDS (8)							12.6	12.6	3.9%
Total	72.9	17.6	9.0	1.3	27.9	0.3	222.7	323.8	100%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle. Carbon emissions calculated from EIA, Assumptions to the AEO 2004 and differ by as much as 2% from EIA, AEO 2004, Table A19. Sector total varies by 0.1% from EIA, AEO 2004. 2) Excludes electric imports by utilities. 3) Includes furnace fans (3.9 MMTCE). 4) Includes refrigerators (21.8 MMTCE) and freezers (6.9 MMTCE). 5) Includes color television (6.3 MMTCE) and other office equipment (9.7 MMTCE). 6) Includes clothes washers (1.6 MMTCE), natural gas clothes dryers (1.0 MMTCE), electric clothes dryers (12.2 MMTCE), and dishwashers (1.2 MMTCE). Does not include water heating energy. 7) Includes small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, and outdoor grills. 8) Emissions related to a discrepancy between data sources. Energy attributable to the sector but not directly to specific end uses.

Source(s): EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 and Table A4, p. 139-140 for energy consumption, and Table A19, p. 158 for emissions; EIA Assumptions to the AEO 2004, Jan. 2004, p. 9 for emission coefficients; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for small electric end-uses.

**3.1.4 2002 Commercial Energy End-Use Carbon Dioxide Emissions Splits, by Fuel Type  
(10<sup>6</sup> metric tons of carbon equivalent) (1)**

	Natural Gas	Petroleum					Coal	Electricity (3)	Total	Percent
		Distil.	Resid.	LPG	Oth(2)	Total				
Lighting								69.9	69.9	25.4%
Space Heating	20.4	3.4	1.7		0.3	5.4	2.5	10.8	39.2	14.2%
Space Cooling	0.2							32.4	32.6	11.9%
Refrigeration								17.4	17.4	6.3%
Water Heating	8.5	1.4				1.4		7.2	17.1	6.2%
Ventilation								16.2	16.2	5.9%
Electronics								16.0	16.0	5.8%
Computers								7.0	7.0	2.6%
Cooking	3.8							1.6	5.4	2.0%
Other (4)	4.1	0.4		1.6	0.9	2.9		15.7	22.7	8.3%
Adjust to SEDS (5)	9.3	4.4				4.4		17.9	31.5	11.5%
Total	46.2	9.6	1.7	1.6	1.2	14.1	2.5	212.2	275.0	100%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle. Carbon emissions calculated from EIA, Assumptions to the AEO 2004 and differ by as much as 2% from EIA, AEO 2004, Table A19. Sector total varies by 0.1% from EIA, AEO 2004.

2) Includes kerosene space (0.3 MMTCE) heating and motor gasoline other uses (0.9 MMTCE). 3) Excludes electric imports by utilities.

4) Includes service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, and manufacturing in commercial buildings. 5) Emissions related to a discrepancy between data sources. Energy attributable to the commercial sector, but not directly to specific end-uses.

Source(s): EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 and Table A5, p. 141-142 for energy consumption, and Table A19, p. 158 for emissions; EIA, National Energy Modeling System for AEO 2004, Jan. 2004; EIA, Assumptions to the AEO 2004, Jan. 2004, p. 9 for emissions coefficients; A.D. Little/BTS, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment and Ventilation, Oct. 1999, p 1-2; BTP/Navigant Consulting, U.S. Lighting Market Characterization, Volume I, Sept. 2002, Table 8-2, p.63; OBT/A.D. Little, Energy Savings Potential for Commercial Refrigeration Equipment, June 1996, Figure 1-1, p. 1-1; and EIA, AEO 1999, Dec. 1998, p. 120 for 1996 refrigeration.

**3.1.5 World Carbon Dioxide Emissions (1)**

Nation/Region	Emissions (10^6 metric tons of carbon)				Annual Growth Rate	
	1990	2000	2010	1990-2000	2000-2010	
United States	1,361	1,578	24.6%	1,789	1.5%	1.3%
Western Europe	931	939	14.6%	973	0.1%	0.4%
China	617	780	12.2%	1,108	2.4%	3.6%
Former Soviet Union	1,036	638	9.9%	709	-4.7%	1.1%
Other Asia	400	633	9.9%	791	4.7%	2.2%
Middle East	231	344	5.4%	427	4.1%	2.2%
Japan	269	310	4.8%	338	1.4%	0.9%
Central & S. America	192	262	4.1%	326	3.2%	2.2%
India	153	249	3.9%	311	5.0%	2.2%
Africa	179	221	3.4%	265	2.1%	1.8%
Eastern Europe	301	206	3.2%	217	-3.7%	0.5%
Canada	129	158	2.5%	187	2.1%	1.7%
Mexico	84	99	1.5%	118	1.7%	1.8%
World Total	5,881	6,419	100%	7,559	0.9%	1.6%

Source(s): EIA, International Energy Outlook 2004, April 2004, Table A9, p. 172.

**3.1.6 2002 Methane Emissions for U.S. Buildings Energy Production, by Fuel Type (10<sup>6</sup> metric tons of carbon equivalent) (1)**

<u>Fuel Type</u>	<u>Residential</u>	<u>Commercial</u>	<u>Buildings Total</u>
Petroleum	0.3	0.1	0.4
Natural Gas	8.5	5.4	14.0
Coal	0.0	0.1	0.1
Wood	1.8	0.0	1.8
Electricity (2)	8.9	8.5	17.3
Total	19.5	14.1	33.5

Note(s): 1) Sources of emissions include oil and gas production, processing, and distribution; coal mining; and utility and *site* combustion. Carbon equivalent units are calculated by converting methane emissions to carbon dioxide emissions (methane's global warming potential is 23 times that of carbon dioxide) and carbon dioxide to carbon equivalent. 2) Emissions of electricity generators attributable to the buildings sector.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 2002, October 2003, Table 13, p. 41 for energy production emissions, and Table 17, p. 44 for stationary combustion emissions; and EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 for energy consumption.

**3.1.7 2002 Carbon Dioxide Emission Coefficients for Buildings (10<sup>6</sup> metric tons of carbon per quad) (1)**

	All <u>Buildings</u>	Residential <u>Buildings</u>	Commercial <u>Buildings</u>
Coal			
Average (2)	25.74	25.74	25.74
Natural Gas			
Average (2)	14.40	14.40	14.40
Petroleum Products			
Distillate Fuel Oil/Diesel	19.75	-	-
Kerosene	19.52	-	-
Motor Gasoline	19.15	-	-
Liquefied Petroleum Gas	17.09	-	-
Residual Fuel Oil	21.28	-	-
Average (2)	19.04	18.80	19.53
Electricity Consumption (3)			
Average - Primary (4)	16.02	16.02	16.02
Average - Site (5)	51.58	51.58	51.58
New Generation			
Gas Combined Cycle - Site (6)	32.64	32.64	32.64
Gas Combustion Turbine - Site (6)	47.61	47.61	47.61
Stock Gas Generator - Site (7)	43.80	43.80	43.80
All Fuels (3)			
Average - Primary	15.64	15.51	15.81
Average - Site	30.69	28.67	33.27

Note(s): 1) Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. The combustion of fossil fuels produces carbon in the form of carbon dioxide and carbon monoxide; however, carbon monoxide emissions oxidize in a relatively short time to form carbon dioxide. 2) Coefficients do not match total emissions reported in the AEO 2004 and were adjusted using Assumptions to the AEO 2004. 3) Excludes electricity imports from utility consumption. Includes nuclear and renewable (including hydroelectric) generated electricity. 4) Use this coefficient to estimate carbon emissions resulting from the consumption of energy by electric generators. 5) Use this coefficient to estimate carbon emissions resulting from the consumption of electricity by end-users. 6) Use this coefficient to estimate emissions of the next-built (2003) natural gas-fired, electric generator resulting from the consumption of electricity by end-users. 7) Use this coefficient to estimate emissions of existing natural gas-fired, electric generators resulting from the consumption of electricity by end-users.

Source(s): EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136, Table A8, p. 145-146, Table A18, p. 157 for consumption and Table A19, p. 158 for emissions; EIA, Assumptions to the AEO 2004, Jan. 2004, Table 2, p. 8 for coefficients and Table 48, p. 84 for generator efficiencies; EIA, Annual Energy Review 2002, Oct. 2003, Diagram 5, p. 219 for T&D losses.

**3.2.1 Halocarbon Environmental Coefficients and Principal Uses**

<u>Compound</u>	<u>100-Year Global Warming Potential (CO<sub>2</sub> = 1)</u>	<u>Ozone Depletion Potential (Relative to CFC-11)</u>	<u>Principal Uses</u>
<b>Chlorofluorocarbons</b>			
CFC-11	4600	1.00	Blowing Agent, Chillers
CFC-12 (1)	10600	1.00	Auto A/C, Chillers, & Blowing Agent
CFC-113	6000	0.80	Solvent
CFC-114	9800	1.00	Solvent
CFC-115 (2)	7200	0.60	Solvent, Refrigerant
<b>Hydrochlorofluorocarbons</b>			
HCFC-22 (2)	1700	0.06	Residential A/C
HCFC-123	120	0.02	Refrigerant
HCFC-124	620	0.02	Sterilant
HCFC-141b	700	0.11	CFC Replacement
HCFC-142b	2400	0.07	CFC Replacement
<b>Bromofluorocarbons</b>			
Halon-1211	1300	3.00	Fire Extinguishers
Halon-1301	6900	10.00	Fire Extinguishers
<b>Hydrofluorocarbons</b>			
HFC-23	12000	0.00	HCFC Byproduct
HFC-125	3400	0.00	CFC/HCFC replacement
HFC-134a	1300	0.00	Auto A/C, Refrigeration
HFC-152a (1)	120	0.00	Aerosol Propellant
HFC-227ea	3500	0.00	CFC Replacement

Note(s): 1) R-500: 74% CFC-12 and 26% HFC-152a. 2) R-502: 49% HCFC-22 and 51% CFC-115.

Source(s): Intergovernmental Panel for Climate Change, Climate Change 2001: The Scientific Basis, January 2001, Table 3, p. 47 for global warming potentials and uses; EPA for halon ODPs; 'AFEAS' Internet Homepage, Atmospheric Chlorine: CFCs and Alternative Fluorocarbons, Feb. 1997 for remaining ODPs; and ASHRAE, 1993 ASHRAE Handbook: Fundamental, p. 16.3 for Notes 1 and 2.

**3.2.2 Conversion and Replacements of Centrifugal CFC Chillers**

	<u>Conversions</u>	<u>Replacements</u>	<u>Total</u>	<u>Cumulative Percent of 1992 Chillers (1)</u>
Pre-1995	2,304	7,208	9,512	12%
1995	1,198	3,915	5,113	18%
1996	1,311	3,045	4,356	24%
1997	815	3,913	4,728	30%
1998	905	3,326	4,231	35%
1999	491	3,085	3,576	39%
2000	913	3,235	4,148	45%
2001	452	3,324	3,776	49%
2002	360	3,433	3,793	54%
2003	334	2,549	2,883	55%
2004 (2)	165	2,883	3,048	59%
2005 (2)	145	3,084	3,229	63%
<u>2006 (2)</u>	<u>125</u>	<u>3,064</u>	<u>3,189</u>	67%
Total	9,518	46,064	55,582	

Note(s): 1) In 1992, approximately 80,000 centrifugal CFC chillers were in service, of which 82% used CFC-11, 12% CFC-12, and 6% CFC-113, CFC-114, or R-500. 2) Projected.

Source(s): ARI, New Legislation Would Spur Replacement of CFC Chillers, March 31, 2004; ARI, Economy Affects CFC Chiller Phaseout, April 2, 2003; ARI, Half-way Mark in Sight for Replacement and Conversion of CFC Chiller Used for Air Conditioning of Buildings, April 11, 2001; ARI, Replacement and Conversion of CFC Chillers Dipped in 1999 Assuring Steady Demand for Non-CFC Units for a Decade, March 29, 2000; ARI, Survey Estimates Long Use of CFC Chillers Nearly Two-Thirds of Units Still in Place, April 15, 1999; ARI, CFCs Widely Used to Cool Buildings Despite 28-Month Ban on Production, April 8, 1998; ARI, 1997 Chiller Survey, April 9, 1997; Air Conditioning, Heating and Refrigeration News, April 1996, p. 1; and ARI's Internet Home Page, Chiller Manufacturer Survey Confirms Slow Pace of Conversion and Replacements of CFC Chillers, April 12, 1995.

**3.2.3 Estimated U.S. Emissions of Halocarbons, 1987-2001 (10<sup>6</sup> metric tons of carbon equivalent)**

Gas	<u>1987</u>	<u>1990</u>	<u>1992</u>	<u>1995</u>	<u>1998</u>	<u>2000</u>	<u>2001 (1)</u>
<b>Chlorofluorocarbons</b>							
CFC-11	107	67	57	45	31	29	29
CFC-12	318	326	233	150	61	50	62
CFC-113	136	43	28	14	0	0	0
CFC-114	N.A.	13	8	4	0	N.A.	N.A.
CFC-115	N.A.	8	7	6	5	N.A.	N.A.
<b>Bromofluorocarbons</b>							
Halon-1211	N.A.	0	0	0	0	N.A.	N.A.
Halon-1301	N.A.	3	3	3	4	N.A.	N.A.
<b>Hydrochlorofluorocarbons</b>							
HCFC-22	32	37	37	34	35	37	37
HCFC-123	N.A.	0	0	0	0	N.A.	N.A.
HCFC-124	0	0	0	1	1	N.A.	N.A.
HCFC-141b	N.A.	0	0	4	5	1	1
HCFC-142b	N.A.	0	0	5	6	7	7
<b>Hydrofluorocarbons</b>							
HFC-23	13	10	10	8	11	9	6
HFC-125	N.A.	0	0	0	1	1	2
HFC-134a	N.A.	0	0	5	10	12	11
Total	605	508	384	279	170	145	154

Note(s): 1) Preliminary.

Source(s): Intergovernmental Panel for Climate Change, Climate Change 2001: The Scientific Basis, January 2001, Table 3, p. 47 for 1999 and 2000 GWPs; EIA, Emissions of Greenhouse Gases in the U.S. 2001, Dec. 2002, Table 29, p. 71 and Table D2, p. D-5 for 1990-2001 emissions; EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1998, Table ES-6, p. ES-9 for HFCs and Annex L, Table L-1, p. L-2 for 1990-1998 ozone depleting refrigerants; and EIA, Emissions of Greenhouse Gases in the U.S. 1985-1994, Oct. 1995, Table 34, p. 54 for 1987.



**3.3.1 2001 EPA Emissions Summary Table for U.S. Buildings Energy Consumption (thousand short tons) (1)**

	Buildings			U.S. Total	Buildings Percent of U.S. Total
	Wood/SiteFossil	Electricity	Total		
SO <sub>2</sub>	549	7,670 (2)	8,219	15,790	52%
NO <sub>x</sub>	1,068	3,467	4,535	22,349	20%
CO	2,919	349	3,268	120,759	3%
VOCs	953	45	998	17,963	6%
PM-2.5	493	403	896	7,380	12%
PM-10	511	470	981	24,101	4%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. VOCs = volatile organic compounds; PM-10 = particulate matter less than 10 micrometers in aerodynamic diameter. PM-2.5 = particulate matter less than 2.5 micrometers in aerodynamic diameter. CO and VOCs site fossil emissions mostly from wood burning. 2) Emissions of SO<sub>2</sub> are 26% lower for 2001 than 1994 estimates since Phase II of the 1990 Clean Air Act Amendments began in 2000. Buildings Energy Consumption related to SO<sub>2</sub> emissions dropped 18% from 1994 to 2001.

Source(s): EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136; and EPA, 2001 Average Annual Emissions, All Criteria Pollutants, February 2003 Tables A-2 to A-8.

**3.3.2 2001 EPA Criteria Pollutant Emissions Coefficients (million short tons/delivered quad, unless otherwise noted)**Residential

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO <sub>2</sub>	0.937	(2)	0.087	(2)	0.287
NO <sub>x</sub>	0.423	0.072	0.113	(2)	0.130
CO	0.043	(2)	(2)	(2)	0.013

Commercial

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO <sub>2</sub>	0.937	(2)	0.328	(2)	0.287
NO <sub>x</sub>	0.423	0.075	0.107	(2)	0.130
CO	0.043	(2)	(2)	(2)	0.013

All Buildings

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO <sub>2</sub>	0.937	(2)	0.166	(2)	0.287
NO <sub>x</sub>	0.423	0.073	0.111	(2)	0.130
CO	0.043	(2)	(2)	(2)	0.013

Note(s): 1) Emissions of SO<sub>2</sub> are 26% lower for 2001 than 1994 estimates since Phase II of the 1990 Clean Air Act Amendments began in 2000. Buildings energy consumption related SO<sub>2</sub> emissions dropped 18% from 1994 to 2001. 2) Data not available, significant enough, or reliable. 3) Oil includes distillate and residual fuel oils, LPG, motor gasoline, and kerosene.

Source(s): EPA, 2001 Average Annual Emissions, All Criteria Pollutants, February 2003 Tables A-2 to A-8 for emissions; and EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 for energy consumption.

**3.4.1 Characteristics of U.S. Construction Waste**

- 2 to 7 tons of waste (a rough average of 4 pounds of waste per square foot) are generated during the construction of a new single-family detached house.
- 15 to 70 pounds of hazardous waste are generated during the construction of a detached, single-family house. Hazardous wastes include paint, caulk, roofing cement, aerosols, solvents, adhesives, oils, and greases.
- Each year, U.S. builders produce between 30 and 35 million tons of construction, renovation, and demolition (C&D) waste.
- Annual C&D debris accounts for roughly 24% of the municipal solid waste stream.
- Wastes include wood (27% of total) and other (at 73% of total, including cardboard and paper; drywall/plaster; insulation; siding; roofing; metal; concrete, asphalt, masonry, bricks, and dirt rubble; waterproofing materials; and landscaping material).
- As much as 95% of buildings-related construction waste is recyclable, and most materials are clean and unmixed.

Source(s): First International Sustainable Construction Conference Proceedings, Construction Waste Management and Recycling Strategies in the U.S., Nov. 1994, p. 689; Fine Homebuilding, Construction Waste, Feb./Mar. 1995, p. 70-75; NAHB, Housing Economics, Mar. 1995, p. 12-13; and Cost Engineering, Cost-Effective Waste Minimization for Construction Managers, Vol. 37/No. 1, Jan. 1995, p. 31-39.

**3.4.2 "Typical" Construction Waste Estimated for a 2,000-Square-Foot Home (1)**

Material	Weight		Volume (cu. yd.) (2)
	(pounds)	(percent)	
Solid sawn wood	1,600	20%	6
Engineered wood	1,400	18%	5
Drywall	2,000	25%	6
Cardboard (OCC)	600	8%	20
Metals	150	2%	1
Vinyl (PVC) (3)	150	2%	1
Masonry (4)	1,000	13%	1
Hazardous Materials	50	1%	-
Other	1,050	13%	11
Total	8,000	100%	50

Note(s): 1) See Table 2.1.7 for materials used in the construction of a new single-family home. 2) Volumes are highly variable due to compressibility and captured air space in waste materials. 3) Assuming 3 sides of exterior clad in vinyl siding. 4) Assuming a brick veneer on home's front facade.

Source(s): NAHB's Internet Home Page, Residential Construction Waste: From Disposal to Management, Oct. 1996.

**3.4.3 1996 Construction and Demolition Debris Generated from Construction Activities and Debris Generation Rates**

	Debris (million tons)				Debris Generation Rates (lbs/ sq. ft.)	
	Residential	Commercial	Buildings		Residential	Commercial
New Construction	6.6	4.3	10.8		4.38	3.89
Demolition	19.7	45.1	64.8		115	155
Renovation	31.9	28.0	59.9		N/A	N/A
Total	58.2	77.4	135.5			

Source(s): EPA/OSW, Characterization of Buildings-Related Construction and Demolition Debris in the United States, June 1998, Tables 3-6, p. 2-3 - 2-8, and Table 8, p. 2-11.

**4.1.1 Building Energy Prices, by Year and Major Fuel Type (\$2002/10<sup>6</sup> Btu) (1)**

	Residential Buildings				Commercial Buildings				Buildings Average (3)
	Electricity	Natural Gas	Petroleum (2)	Avg	Electricity	Natural Gas	Petroleum (2)	Avg	
1980	30.48	6.98	14.08	14.71	31.16	6.44	10.94	15.47	15.01
1990	29.37	7.20	11.28	15.60	27.11	6.01	7.57	15.56	15.58
2000	24.14	7.63	8.13	13.98	21.52	6.57	8.01	14.10	14.03
<b>2002</b>	<b>24.73</b>	<b>7.65</b>	<b>9.87</b>	<b>14.75</b>	<b>22.82</b>	<b>6.37</b>	<b>6.88</b>	<b>14.84</b>	<b>14.79</b>
2005	24.13	8.39	9.81	14.78	21.07	7.17	6.45	14.28	14.56
2010	23.30	7.67	9.90	14.22	20.39	6.64	6.34	13.89	14.08
2020	23.73	8.24	10.86	15.10	21.21	7.31	6.83	15.05	15.07
2025	23.88	8.32	11.26	15.39	21.48	7.41	6.98	15.39	15.39

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. 2) Petroleum products include distillate fuel, oil, residual fuel oil, LPG, kerosene, and motor gasoline. 3) In 2002, Buildings average electricity price was \$23.80/10<sup>6</sup> Btu or (\$0.081/kWh), average natural gas price was \$7.15/10<sup>6</sup> Btu (\$7.40/1000 CF), and petroleum was \$8.89/10<sup>6</sup> Btu (\$1.02/gal.). Averages do not include wood or coal prices.

Source(s): EIA, State Energy Data 2000, April 2003, p. Tables 2-3, p. 24-25 for 1980, 1990 and 2000 and prices for note, Tables 8-9, p. 18-19 for 1980, 1990 and 2000 consumption; EIA, AEO 2004, Jan. 2004, Table A2, p. 135-136, Table A3, p. 137-138, Table A12, p. 151, and Table A14, p. 153 for 2002-2025 consumption; and prices; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.1.2 Building Energy Prices, by Year and Fuel Type (\$2002)**

	Residential Buildings				Commercial Buildings			
	Electricity (¢/kWh)	Natural Gas (¢/therm)	Distillate Oil (\$/gal)	LPG (\$/gal)	Electricity (¢/kWh)	Natural Gas (¢/therm)	Distillate Oil (\$/gal)	Residual Oil (\$/gal)
1980	10.4	69.8	1.89	1.32	10.6	64.4	1.74	1.20
1990	10.0	72.0	1.42	1.20	9.2	60.1	1.05	0.65
2000	8.5	79.0	1.43	1.29	7.6	68.0	1.07	0.70
<b>2002</b>	<b>8.4</b>	<b>76.5</b>	<b>1.14</b>	<b>1.11</b>	<b>7.8</b>	<b>63.7</b>	<b>0.84</b>	<b>0.63</b>
2005	8.2	83.9	1.11	1.17	7.2	71.7	0.78	0.60
2010	7.9	76.7	1.08	1.19	7.0	66.4	0.76	0.62
2020	8.1	82.4	1.16	1.27	7.2	73.1	0.83	0.66
2025	8.1	83.2	1.18	1.30	7.3	74.1	0.85	0.68

Source(s): EIA, State Energy Data 2000, April 2003, p. Tables 2-3, p. 24-25 for 1980-2000; EIA, AEO 2004, Jan. 2004, Table A3, p. 137-138 for 2002-2025 prices and Table H1, p. 262 for fuels' heat content; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.1.3 Buildings Aggregate Energy Expenditures, by Year and Major Fuel Type (\$2002 billion) (1)**

	Residential Buildings				Commercial Buildings				Total Building Expenditures
	Electricity	Natural Gas	Petroleum (2)	Total	Electricity	Natural Gas	Petroleum (2)	Total	
1980	74.6	33.9	24.6	133.2	59.4	17.2	14.1	90.7	223.9
1990	92.6	32.5	14.3	139.4	77.5	16.2	6.9	100.6	240.1
2000	101.7	40.3	18.2	160.2	88.1	22.4	6.2	116.8	277.0
<b>2002</b>	<b>107.0</b>	<b>38.7</b>	<b>14.6</b>	<b>160.4</b>	<b>94.1</b>	<b>20.4</b>	<b>5.0</b>	<b>119.5</b>	<b>279.9</b>
2005	108.6	44.9	15.6	169.1	93.2	23.4	5.6	122.2	291.3
2010	113.5	43.6	15.8	173.0	103.0	23.7	5.8	132.6	305.5
2020	132.9	50.1	17.0	200.0	132.3	28.8	6.7	167.7	367.7
2025	142.3	52.1	17.2	211.7	146.8	30.8	7.0	184.6	396.3

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures exclude wood and coal. 2002 U.S. energy expenditures were \$682.1 billion. 2) Petroleum products include distillate fuel oil, residual fuel oil, LPG, kerosene and motor gasoline

Source(s): EIA, State Energy Data 2000, April 2003, p. 24-25 for 1980, 1990 and 2000; EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 and Table A3, p. 139-140 for 2002-2025; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.1.4 FY 2001 Federal Buildings Energy Prices and Expenditures, by Fuel Type (\$2002)**

Average Fuel Prices			
Fuel Type	(\$/million Btu)	Total Expenditures (\$million) (2)	
Electricity	18.55 (1)	2,660.5	
Natural Gas	7.35	805.4	
Fuel Oil	6.38	265.9	
Coal	2.10	31.1	
Purchased Steam	12.94	170.2	
LPG/Propane	10.85	30.4	
Other	8.40	17.1	
Average	12.16	Total	3,980.7

Note(s): 1) \$0.063/kWh. 2) Energy used in buildings FY 2001 accounted for 40.6% of the total Federal energy bill.

Source(s): DOE, Annual Report to Congress on FEMP, February 2004, p. 63 for buildings expenditures, and p. 13 for Federal energy expenditures.

EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

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**4.1.5 2002 Buildings Energy End-Use Expenditure Splits, by Fuel Type (\$2002 billion) (1)**

	Natural Gas	Petroleum					Coal	Electricity	Total	Percent
		Distil.	Resid.	LPG	Oth(2)	Total				
Space Heating (3)	36.1	7.4	0.3	3.9	0.8	12.4	0.2	16.6	65.2	23.3%
Lighting								50.0	50.0	17.8%
Space Cooling	0.1							34.3	34.3	12.2%
Water Heating (4)	12.5	1.4		0.6		2.1		13.3	27.9	10.0%
Refrigeration (5)								21.5	21.5	7.7%
Electronics (6)								14.8	14.8	5.3%
Cooking	3.3			0.4		0.4		6.1	9.8	3.5%
Wet Clean (7)	0.5							7.2	7.8	2.8%
Ventilation (8)								7.2	7.2	2.6%
Computers								4.7	4.7	1.7%
Other (9)	1.8	0.1		3.1	0.6	3.9		11.4	17.1	6.1%
Adjust to SEDS (10)	4.8	1.3				1.3		14.0	20.1	7.2%
Total	59.1	10.3	0.3	8.0	1.4	20.0	0.18	201.1	280.4	100%

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes kerosene space heating (\$0.8 billion) and motor gasoline other uses (\$0.6 billion). 3) Includes furnace fans (\$1.9 billion). 4) Includes residential recreation water heating (\$1.0 billion). 5) Includes refrigerators (\$13.8 billion) and freezers (\$4.6 billion). 6) Includes color televisions (\$3.0 billion) and other electronics (\$4.7 billion). 7) Includes clothes washers (\$0.8 billion), natural gas clothes dryers (\$0.5 billion), electric clothes dryers (\$5.9 billion) and dishwashers (\$6.6 billion). 8) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. (\$0.5 billion). 9) Includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills, and natural gas outdoor lighting. Includes commercial services station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, manufacturing performed in commercial buildings. 10) Expenditures related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential and commercial buildings sectors, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2004, Jan. 2004, Table A2, p. 134-136, Table A3, p. 137-138 for prices, Table A4, p. 139-140 for residential energy consumption, and Table A5, p. 141-142 for commercial energy consumption; EIA, National Energy Modeling System for AEO 2003, March 2003; EIA, State Energy Data 2000, April 2003, p. 24-25 for coal and minor petroleum prices; EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses; BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2, 5-25 and 5-26 for commercial ventilation; BTP/Navigant Consulting, U.S. Lighting Market Characterization, Volume I, Sept. 2002, Table 8-2, p. 63 for commercial lighting; OBT/A.D. Little, Energy Savings Potential for Commercial Refrigeration Equipment, June 1996, Figure 1-1-, p. 1-1; and EIA, AEO 1999, Dec. 1998, Table A5, p. 120 for 1996 commercial refrigeration.

**4.1.6 Implicit Price Deflators (1996 = 1.00)**

<u>Year</u>	<u>Implicit Price Deflator</u>	<u>Year</u>	<u>Implicit Price Deflator</u>	<u>Year</u>	<u>Implicit Price Deflator</u>
1980	0.57	1990	0.87	2000	1.07
1981	0.62	1991	0.90	2001	1.09
1982	0.66	1992	0.92	2002	1.11
1983	0.69	1993	0.94		
1984	0.71	1994	0.96		
1985	0.74	1995	0.98		
1986	0.75	1996	1.00		
1987	0.78	1997	1.02		
1988	0.80	1998	1.03		
1989	0.83	1999	1.05		

Source(s): EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353.

**4.2.1 2002 Residential Energy End-Use Expenditure Splits, by Fuel Type (\$2002 billion) (1)**

	Natural	Petroleum				Coal	Electricity	Total	Percent
	Gas	Distil.	LPG	Kerosene	Total				
Space Heating (2)	27.1	6.3	3.9	0.6	10.8	0.0	11.8	49.7	31.0%
Water Heating (3)	8.8	1.0	0.6		1.6		10.1	20.5	12.8%
Space Cooling (4)	0.0						19.9	19.9	12.4%
Lighting							19.0	19.0	11.8%
Refrigeration (5)							13.8	13.8	8.6%
Wet Clean (6)	0.5						7.2	7.8	4.8%
Electronics (7)							7.7	7.7	4.8%
Cooking	1.6		0.4		0.4		5.4	7.4	4.6%
Computers							1.6	1.6	1.0%
Other (8)	0.0	0.0	1.9		1.9		4.4	6.3	4.0%
Adjust to SEDS (9)	0.7						6.0	6.8	4.2%
Total	38.7	7.3	6.8	0.6	14.8	0.03	107.0	160.5	100%

Note(s): 1) Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes furnace fans (\$1.9 billion). 3) Includes residential recreation water heating (\$1.0 billion). 4) Fan energy use included. 5) Includes refrigerators (\$10.5 billion) and freezers (\$3.3 billion). 6) Includes clothes washers (\$0.8 billion), natural gas clothes dryers (\$0.5 billion), electric clothes dryers (\$5.9 billion), and dishwashers (\$0.6 billion). 7) Includes color televisions (\$3.0 billion) and other electronics (\$4.7 billion). 8) Includes small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills, and natural gas outdoor lighting. 9) Expenditures related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential building sector, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2004, Jan. 2004, Table A2, p. 134-136, Table A3, p. 137-138 for prices, and Table A4, p. 139-140 for residential energy; EIA, State Energy Data 2000, November 2001, p. 24-25 for coal and minor petroleum prices; EIA, Annual Energy Review 2002, October 2003, Appendix D, p. 353 for price deflators; and BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses.

**4.2.2 Average Annual Energy Expenditures per Household, by Year (\$2002)**

1980	1,672
1990	1,480
2000	1,442
<b>2002</b>	<b>1,454</b>
2005	1,488
2010	1,443
2020	1,514
2025	1,536

Source(s): EIA, State Energy Data 2000, April 2003, p. 24 for 1980, 1990 and 2000; EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136, Table A4, p. 139-140 for consumption, Table A3, p. 137-138 for prices 2002-2025; EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators and DOC, Statistical Abstract of the United States 2003, Feb. 2004, Table No. 953, p. 615 for 1980 and 1990 occupied units.

**4.2.3 2001 Energy Expenditures per Household, by Housing Type and Square Footage (\$2002)**

	<u>Per Household</u>	<u>Per Square Foot</u>
<b>Single Family</b>	<b>1,710</b>	<b>0.78</b>
-Detached	1,738	0.72
-Attached	1,545	0.70
<b>Multi-Family</b>	<b>924</b>	<b>0.96</b>
-2 to 4 units	1,270	0.91
-5 or more units	801	0.94
<b>Mobile Home</b>	<b>1,350</b>	<b>1.28</b>

Source(s): EIA, A Look at Residential Energy Consumption in 2001, Oct. 2003, Table CE1-6.2u; and EIA, Annual Energy Review 2002, October 2003, Appendix D, p. 353 for price inflators.

**4.2.4 2001 Energy Expenditures per Household, by Census Region (\$2002)**

Northeast	1,753
Midwest	1,556
South	1,538
West	1,178

Source(s): EIA, A Look at Residential Energy Consumption in 2001, Oct. 2003, Tables CE1-9c, CE1-10c, CE1-11c and CE1-12c; and EIA, Annual Energy Review 2001, Nov. 2002, Appendix E, p. 353 for price inflators.

**4.2.5 2001 Household Energy Expenditures, by Vintage (\$2002)**

<u>Year</u>	<u>Per Household</u>	<u>Per Square Foot</u>	<u>Per Household Member</u>	<u>Percent of Residential Sector Expenditures</u>
Prior to 1970	1,529	0.78	599	52%
1970 to 1979	1,395	0.80	557	16%
1980 to 1989	1,445	0.75	578	16%
1990 to 1999	1,598	0.68	546	14%
2000 to 2001	1,871	0.62	554	1%
				<u>100%</u>
Average	1,504	0.76	581	

Source(s): EIA, A Look at Residential Energy Consumption in 2001, Oct. 2003, Tables CE1-6.1u and CE1-6.2u; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price inflators.

**4.2.6 2001 Households and Energy Expenditures, by Income Level (\$2002)**

<u>Family Income/Year</u>	<u>Households</u>		<u>Energy Expenditures by</u>		<u>Percent of Income for Energy Expenditures (1)</u>
	<u>Number(10^6)</u>	<u>Percent</u>	<u>Household</u>	<u>Household Member</u>	
Less than \$9,999	11.0	10%	1,042	555	16%
\$10,000 to \$14,999	7.7	7%	1,118	525	9%
\$15,000 to \$19,999	8.9	8%	1,278	560	7%
\$20,000 to \$29,999	14.0	13%	1,315	560	5%
\$30,000 to \$39,999	13.9	13%	1,379	540	4%
\$40,000 to \$49,999	13.2	12%	1,515	561	3%
\$50,000 to \$74,999	21.7	20%	1,671	573	3%
\$75,000 to \$99,999	8.1	8%	1,830	626	2%
<u>\$100,000 or more</u>	<u>8.6</u>	<u>8%</u>	<u>2,242</u>	<u>736</u>	<u>2%</u>
Total	107.1	100%			3%

Note(s): 1) See Tables 4.2.7 and 7.1.10 for more on energy burdens.

Source(s): EIA, A Look at Residential Energy Consumption in 2001, Oct. 2003, Tables CE1-5.1u.

**4.2.7 Energy Burden Definitions and Residential Energy Burdens, by Weatherization Eligibility and Year (1)**

Energy burden is an important statistic for policy makers who are considering the need for energy assistance. Energy burden can be defined broadly as the burden placed on household incomes by the cost of energy, or more simply the ratio of energy expenditures to income for a household. However, there are different ways to compute energy burden, and different interpretations and uses of the energy burden statistics. DOE Weatherization primarily uses mean individual burden and mean group burden since these statistics provide data on how an "average" individual household fares against an "average" group of households (that is, how burdens are distributed for the population). DOE Weatherization (and HHS) also uses the median individual burden which shows the burden of a "typical" individual.

	1987	1990			FY 2002 (2)		
	Mean	Mean	Mean	Mean	Mean	Mdn	Mean
	<u>Group</u>	<u>Indvdl</u>	<u>Indvdl</u>	<u>Group</u>	<u>Indvdl</u>	<u>Indvdl</u>	<u>Group</u>
Total US Households	4.0%	6.8%	N.A.	3.2%	5.9%	3.2%	2.4%
Federally Eligible	13.0%	14.4%	N.A.	10.1%	12.6%	7.5%	7.5%
Federally Ineligible	4.0%	3.5%	N.A.	N.A.	2.7%	2.4%	1.9%
Below 125% Poverty Line	13.0%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note(s): 1) See Section 7.1 for more on low-income housing. 2) Data are derived from RECS 2001, adjusted to reflect FY 2002, HDD, CDD, and fuel prices.

Source(s): HHS, LIHEAP Home Energy Notebook FY 2002, April 2004, Tables A-2a to A-2c, p. 50-52 for FY2002 burdens; HHS, LIHEAP Report to Congress FY 1995, Aug. 1997, p. 55 for energy burden definitions; HHS, Characterizing the Impact of Energy Expenditures on Low Income Households: An Analysis of Alternative National Energy Burden Statistics, November 1994, p. vii-ix for burdens; ORNL, Scope of the of the Weatherization Assistance Program: Profile of the Population in Need, Mar. 1994, p. xii for mean individual and mean group burdens and p. xi. for 1990 Federally ineligible mean individual burden; and EIA, Household Energy Consumption and Expenditures 1987, Oct. 1989, Table 13, p. 48-50 for 1987 mean group burdens.

**4.2.8 1998 Cost Breakdown of a 2,150 Square Foot, New Single-Family Home (\$2002) (1)**

	Cost	Percent
<b>Finished Lot</b>	57,385	24%
<b>Construction Cost</b>		
Inspection/Fees	3,750	2%
Shell/Frame		
Framing	27,461	11%
Windows/Doors	9,121	4%
Exterior Finish	10,038	4%
Foundation	14,324	6%
Wall/Finish Trim	25,051	10%
Flooring	6,403	3%
Equipment		
Plumbing	7,847	3%
Electrical Wiring	5,007	2%
Lighting Fixtures	1,385	1%
HVAC	5,479	2%
Appliances	1,923	1%
Property Features	15,599	6%
<b>Financing</b>	4,574	2%
<b>Overhead &amp; General Expenses</b>	13,891	6%
<b>Marketing</b>	3,410	1%
<b>Sales Commission</b>	8,203	3%
<b>Profit</b>	22,343	9%
<b>Total</b>	243,193	100%

Note(s): 1) Based on a NAHB survey asking builders to provide a detailed breakdown of the cost of constructing a 2,150-sq.ft. house with 3 or 4 bedrooms on a 7,500- to 10,000-sq.ft. lot. Average sales price of a new home in 42 surveyed markets was \$226,680 (in \$1998).

Source(s): NAHB, The Truth About Regulatory Barriers to Housing Affordability, 1999, p. 4; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price inflators.



**4.3.1 2002 Commercial Energy End-Use Expenditure Splits, by Fuel Type (\$2002 billion) (1)**

	Natural	Petroleum					Coal	Electricity	Total	Percent
	Gas	Distil.	Resid.	LPG	Oth(2)	Total				
Lighting								31.0	31.0	25.9%
Space Heating	9.0	1.1	0.3		0.1	1.5	0.2	4.8	15.5	12.9%
Space Cooling	0.1							14.4	14.5	12.1%
Water Heating	3.8	0.4				0.4		3.2	7.4	6.2%
Refrigeration								7.7	7.7	6.4%
Ventilation								7.2	7.2	6.0%
Electronics								7.1	7.1	5.9%
Computers								3.1	3.1	2.6%
Cooking	1.7					0.0		0.7	2.4	2.0%
Other (3)	1.8	0.1		1.2	0.6	1.9		7.0	10.7	9.0%
Adjust to SEDS (4)	4.1	1.3				1.3		7.9	13.3	11.1%
Total	20.4	3.0	0.3	1.2	0.7	5.2	0.15	94.1	119.9	100%

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes kerosene space heating (\$0.1 billion) and motor gasoline other uses (\$0.6 billion). 3) Includes service station equipment, automated teller machines, medical equipment, telecommunications equipment, pumps, lighting, emergency electric generators, and manufacturing performed in commercial buildings. 4) Expenditures related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the commercial buildings sector, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2004, Jan. 2004, Table A2, p. 134-136, Table A3, p. 137-138 for prices, and Table A5, p. 141-142 for commercial energy consumption; EIA, National Energy Modeling System for AEO 2004, March 2004; EIA, State Energy Data Report 2000, April 2003, p. 24-25 for coal and minor petroleum prices; EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators; BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation Oct. 1999, p. 1-2, 5-25 and 5-26 for ventilation; BTP/Navigant Consulting, U.S. Lighting Market Characterization, Volume I, Sept. 2002, Table 8-2, p. 63; OBT/A.D. Little, Energy Savings Potential for Commercial Refrigeration Equipment, June 1996, Figure 1-1-, p. 1-1; and EIA, AEO 1999, Dec. 1998, Table A5, p. 120 for 1996 refrigeration.

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**4.3.2 Average Annual Energy Expenditures per Square Foot of Commercial Floorspace, by Year (\$2002)**

1980	1.78
1990	1.57
2000	1.70
<b>2002</b>	<b>1.66</b>
2005	1.57
2010	1.58
2020	1.75
2025	1.81

Source(s): EIA, State Energy Data 2000, April 2003, p. 15 for 1980, 1990 and 2000; EIA, AEO 2004, Jan. 2004, Table A2, p. 134-136 and Table A5, p. 141-142 for consumption, Table A3, p. 137-138 for prices for 2002-2025; EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators; EIA, AEO 1994, Jan. 1994, Table A5, p. 62 for 1990 floorspace; and PNNL for 1980 floorspace.

**4.3.3 1999 Energy Expenditures per Square Foot of Commercial Floorspace and per Building, by Building Type (\$2002)**

	<u>per Square Foot</u>	<u>per Building (10<sup>3</sup>)</u>		<u>per Square Foot</u>	<u>per Building (10<sup>3</sup>)</u>
Food Sales	3.82	21.8	Public Order and Safety	1.11	17.9
Food Service	3.65	19.3	Mercantile	1.33	20.7
Health Care	2.05	47.0	Service	1.45	10.3
Office	1.56	25.5	Education	0.98	25.9
Lodging	1.33	39.4	Warehouse and Storage	0.61	10.6
Public Assembly	1.23	17.7	Vacant (1)	0.37	3.5

Note(s): 1) Includes vacant and religious worship.

Source(s): EIA, Commercial Buildings Energy Consumption and Expenditures 1999, July 2002, Table 4; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.3.4 1999 Energy Expenditures per Square Foot of Commercial Floorspace, by Vintage (\$2002)**

Prior to 1980	1.18
1980 to 1989	1.40
1990 to 1999	1.51

Average 1.28

Source(s): EIA, Commercial Buildings Energy Consumption and Expenditures 1999, July 2002, Table C4; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price inflators.

**4.4.1 Annual Energy Expenditures per Gross Square Foot of Federal Floorspace Stock, by Year (\$2002)**

FY 1985	1.78
FY 2000	1.14
FY 2001	1.30

Note(s): Total Federal buildings and facilities energy expenditures in FY 2001 were \$3.98 billion (in \$2002).

Source(s): DOE/FEMP, Annual Report to Congress on FEMP, February 2004, Table 7-B, p. 63 for energy costs and Table 8-A, p. 66 for floorspace; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.4.2 Direct Appropriations on Federal Buildings Energy Conservation Retrofits and Capital Equipment (\$2002 million)**

FY 1985	388.0	FY 1991	140.6	FY 1997	217.5
FY 1986	285.0	FY 1992	174.7	FY 1998	279.9
FY 1987	82.2	FY 1993	142.1	FY 1999	216.8
FY 1988	90.5	FY 1994	265.2	FY 2000	125.1
FY 1989	69.4	FY 1995	325.1	FY 2001	132.8
FY 1990	75.9	FY 1996	198.3		

Source(s): DOE/FEMP, Annual Report to Congress on FEMP, February 2004, Table 4-B, p. 38; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.5.1 Estimated Value of All U.S. Construction Relative to the GDP (\$2002)**

- 2002 estimated value of all U.S. construction is \$1.33 trillion (including renovation; heavy construction; public works; residential, commercial, and industrial new construction; and non-contract work).
- Compared to the \$10.4 trillion U.S. gross domestic product (GDP), all construction holds a 12.7% share.
- In 2002, residential and commercial building renovation (valued at \$329 billion) and new building construction (valued at \$556 billion) is estimated to account for just over 70% (or around \$937 billion, including an additional \$52 billion for non-contract work) of the \$1.33 trillion.

Source(s): National Science and Technology Council, Construction & Building: Interagency Program for Technical Advancement in Construction and Building, 1999, p. 5; National Science and Technology Council, Construction & Building: Federal Research and Development in Support of the U.S. Construction Industry, 1995, p. 5 for value of total U.S. construction and non-contract work; DOC, Current Construction Reports: Value of Construction Put in Place (C30), Jan. 2002, Table 1, p. 3 for 1997; DOC/NIST, An Approach for Measuring Reductions in Operations, Maintenance, and Energy Costs: Baseline Measures of Construction Industry Practices for the National Construction Goals, July 1998, p. 27-35; DOC, 1997 Census of Construction Industries: Industry Summary, Jan. 2000, Table 7, p. 15; DOC, Annual Value of Public Construction Put in Place, April 2004; DOC, Annual Value of Private Construction Put in Place, April 2004; DOC, Expenditures for Residential Improvements and Repairs by Property Type, Quarterly, March 2004; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for price deflators.

**4.5.2 Value of New Building Construction Relative to GDP, by Year (\$2002 billion)**

	Value of New Construction Put in Place			GDP	Bldgs. Percent of Total U.S. GDP
	Residential	Commercial (1)	All Bldgs. (1)		
1980	138.9	133.8	272.7	5,423	5.0%
1985	178.4	189.1	367.5	6,327	5.8%
1990	173.9	189.6	363.5	7,423	4.9%
1995	198.6	173.8	372.4	8,348	4.5%
2000	279.5	269.5	549.0	10,171	5.4%
2002	304.5	251.2	555.7	10,446	5.3%

Note(s): 1) New buildings construction differs from Table 4.5.1 by excluding industrial building construction.

Source(s): DOC, Current Construction Reports: Value of New Construction Put in Place, C30, Aug. 2003, Table 1 for 1980-2000; DOC, Annual Value of Private Construction Put in Place, April 2004; DOC, Annual Value of Public Construction Put in Place, April 2004 for 2002; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for GDP and price deflators.

**4.5.3 Value of Building Improvements and Repairs Relative to GDP, by Year (\$2002 billion) (1)**

	Value of Improvements and Repairs			GDP	Bldgs. Percent of Total U.S. GDP
	Residential	Commercial	All Bldgs.		
1980	89.9	N.A.	N.A.	5,423	N.A.
1985	123.3	117.2 (2)	240.5	6,327	3.8%
1990	147.7	118.8 (3)	266.4	7,423	3.6%
1995	141.0	112.8	253.8	8,348	3.0%
2000	158.4	161.5	319.9	10,171	3.1%
2002	173.3	155.9	329.2	10,446	3.2%

Note(s): 1) Improvements includes additions, alterations, reconstruction, and major replacements. Repairs include maintenance.  
2) 1986. 3) 1989.

Source(s): DOC, Expenditures for Residential Improvements and Repairs by Property Type, Quarterly, March 2004 for 1980-2002; DOC, Current Construction Reports: Expenditures for Nonresidential Improvements and Repairs: 1992, CSS/92, Sept. 1994, Table A, p. 2 for 1986-1990 expenditures; DOC/NIST, An Approach for Measuring Reductions in Operations, Maintenance, and Energy Costs: Baseline Measures of Construction Industry Practices for the National Construction Goals, July 1998, p. 27-35; DOC, 1992 Census of Construction Industries: United States Summary, June 1996, Table 11, p. 16; DOC, 1997 Census of Construction Industries: Industry Summary, Jan. 2000, Table 7, p. 15; DOC, Current Construction Reports: Value of Construction Put in Place, C30, Aug. 2003, Table 1, p. 3 for 1995-2000; DOC, Annual Value of Private Construction Put in Place, Apr. 2004 for 2002; DOC, Annual Value of Public Construction Put in Place, Apr. 2004 for 2002; and EIA, Annual Energy Review 2002, Oct. 2003, Appendix D, p. 353 for GDP and price deflators.

**4.5.4 2003 U.S. Private Investment into Construction R&D**

Sector	Percent of Sales		Percent of Sales	
<b>Average Construction R&amp;D (1)</b>	<b>1.9</b>	(2)	<b>Building Technology</b>	
Heavy Construction	2.0		Appliances	2.0
Special Trade Construction	0.2		Lighting	1.2
			HVAC	1.5
<b>U.S. Average of All Private R&amp;D (2)</b>	<b>3.4</b>	(2)	Fans, Blowers, & Air Cleaning Equipment	1.6
Manufacturing Average	3.3	(2)	Lumber and Wood Products	0.3
Service Industry Average	3.8	(2)	Commercial Building Operations	2.2

Note(s): 1) Includes all construction (e.g., bridges, roads, dams, buildings, etc.). 2) Actually 2000.

Source(s): National Science Foundation, Research and Development in Industry: 2000, May 2003, Table A-20, p. 74-76; and Schonfeld & Associates, R&D Ratios & Budgets, June 2003, p. 219-222.

**4.5.5 2000 International Investment into Construction and Energy R&D**

	Percent of Private R&D to Total Private R&D			R&D Expenditures (millions of PPP dollars) (1)			
	Construction	Electricity, Gas, & Water	Agriculture & Mining (2)	Construction	Electricity, Gas, & Water	Agriculture & Mining	Total
U.S.	0.1	0.1	0.1	200	200	200	199,500
Canada	0.2	1.6	2.9	18	144	261	9,000
Germany	0.2	0.3	0.5	75	112	187	37,400
France (3)	0.9	2.5	1.8	173	480	346	19,200
Italy	0.2	0.2	0.0	15	15	-	7,400
Japan	1.7	0.9	0.0	1,185	627	-	69,700
United Kingdom	0.3	1.4	1.4	53	249	249	17,800
Russian Fed. (4)	0.9	0.5	3.3	51	29	188	5,700
South Korea	3.7	1.8	0.0	522	254	-	14,100
Sweden (3)	0.4	0.6	1.1	24	35	65	5,900
Finland	1.0	1.2	0.7	31	37	22	3,100

Note(s): 1) Purchasing power parity is the equivalent buying power of different currencies. Currency units show the same cost of goods and services in another country as one currency unit would buy at home. 2) Percentages are from 1997 and 1998. 3) 1998. 4) 1997.

Source(s): National Science Foundation, Science & Engineering Indicators -- 2004, Volume 1, May 2004, Table 4-20, p. 4-56.

**4.6.1 Buildings Design and Construction Trades, by Year**

	Employees, in thousands			Number of Residential Builder Establishments with Payrolls, in thousands (2)			
	Architects	Construction (1)		New Construction	Remodeling	Both	Total (3)
1980	N.A.	3065	1982	14.4	21.7	57.5	93.6
1990	N.A.	3861	1987	38.4	32.8	48.1	119.3
2000	(4)	215	1992	36.3	43.3	51.0	130.6
			1997	46.6	33.6	52.1	134.1

Note(s): 1) Does not include industrial building or heavy construction (e.g., dam and bridge building). In 1999, 76% of the employment shown is considered for "production". The entire U.S. construction industry employs an estimated 10 million people, including manufacturing. 2) In 2000, NAHB report having 200,000 members, one-third of which were builders. 3) Excludes homebuilding establishments without payrolls, estimated by NAHB at an additional 210,000 in 1992. 4) NAHB reports that 2,448 full-time jobs in construction and related industries are generated from the construction of every 1,000 single-family homes and 1,030 jobs are created from the construction of every 1,000 multi-family units.

Source(s): DOC, Statistical Abstract of the U.S. 2001, May 2002, Table 593, p. 380 for architect employment, Table 609, p. 393; DOC, 1992 Census of Construction Activities: U.S. Summary, CC92-I-27, Jan. 1996, p. 27-5 for construction employees; DOC, 1997 Economic Census: Construction - Industry Summary, EC97C23IS, Jan. 2000, Table 2, p. 8 for industrial builders; DOC, 1997 Economic Census: Construction - Single-Family Housing Construction, EC97C-2332A, Nov. 1999, Table 10, p. 14 for 1997 builder establishments; NAHB, Housing Economics, May 1995, Table 2, p. 14 for 1982-1992 builder establishments; National Science and Technology Council, Construction & Building: Federal Research and Development in Support of the U.S. Construction Industry for construction employees in Note 1; NAHB, Housing at the Millennium: Facts, Figures, and Trends, May 2000, p. 21 for Note 2; and NAHB, 1997 Housing Facts, Figures and Trends, 1997, p. 35 for Note 3 and p. 13 for Note 4.

**4.6.2 Heating, Cooling, and Ventilation Equipment Trades, by Year (1000 employees)**

Industry	1980	1985	1990	1995	2000	2002
Air Conditioning and Refrigeration Equipment (incl. warm-air furnaces): SIC 3585						
- Total Employment	118.4	122.8	126.9	136.3	150.2	128.5
- Production Workers	81.6	87.2	92.4	102.4	111.6	92.7
Plumbing, Heating, and Air-Conditioning Contractors: SIC 171						
- Total Employment	532.8	605.1	649.2	736.5	928.5	917.0
- Construction Workers	400.4	447.3	476.7	542.4	687.2	670.0
Wholesalers of Hardware, Plumbing and Heating Equipment: SIC 507						
- Total Employment	242.7	254.1	283.8	288.2	318.3	312.9

Source(s): ARI, Statistical Profile of the Air-Conditioning, Refrigeration, and Heating Industry (from U.S. Bureau of Labor Statistics), April 2001, Table 3, p. 10, Table 4, p. 11, Table 5, p. 13, Table 6, p. 14, and Table 8, p. 16 for 1980 to 1990 data; ARI, Statistical Profile of the Air-Conditioning, Refrigeration and Heating Industry, April 2003, Table 3, p. 9, Table 4, p. 10, Table 5, p. 12, Table 6, p. 13 and Table 8, p. 15 for 1995 to 2002 data.